LONGEVITY AND FECUNDITY OF *Gasteroclisus rhomboidalis* (COLEOPTERA: CRUCULIONDAE) ON *Amaranthus* SPECIES

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ABSTRACT

Both the cultivated and the wild spinach (Amaranthus species) have been found to be host to an important beetle pest Gasteroclisus rhomboidalis. The longevity of the beetles was studied under a variety of conditions. It was observed that the life span of the beetles varied widely with the beetles capable of leaving up to 70 days (about 42 days 0n the average). The beetles generally lived longer under the ambient condition than inside room condition. Studies on the survivorship of the immature stages of the beetles revealed that the larva has the highest mortality rate amongst stages with the egg being the highest surviving stage. Studies on the fecundity of the female adult beetles showed that about 80% of their life span is utilised in egg laying. On the average, about 2½ eggs are laid per day (i.e. about 5 eggs laid within 2 days).

Keywords: Longevity, Fecundity, *Gasteroclisus rhomboidalis,* Coleoptera, Cruculiondae, *Amaranthus* species

INTRODUCTION

Leafy vegetables form an important part of the human diet as they provide cheap supplement to minerals, vitamins and protein. In Nigeria, spinach (Amaranthus) as well as other vegetable crops is grown with minimum attention, mainly as minor backyard garden crop. *Gasteroclisus rhomboidalis* (Curculionidae) is a pest of the widely cultivated African spinach, *Amaranthus* species. *G. rhomboidalis* feeds on the leaves of the plant or bore the leaf axils and stems to deposit eggs. The resulting larvae also tunnel inside the host plant stem tissues in the course of their growth and development (Eluwa, 1979). As larvae, the beetles are powerful borers (Kirkpatrick, 1957; Ross, 1965; Davidson and Lyon, 1979).

These activities of the adult beetle and its larvae cause leaf withering and outright snapping and premature death of infested stands of the spinach (Eluwa, 1977). In addition; these could predispose the crops to bacteria and fungi infections. Cultivated varieties of A*maranthus* serve as critical early wet season vegetable for human and as fodder for cattle (Keay, 1973; Eze, 1986; Purseglove, 1987).

A comprehensive study on some aspects of the biology of *G. rhomboidalis* has been reported elsewhere (Ekechukwu, 2002). The full life cycle of the beetle (from copulation and oviposition through the various immature stages to the emergence of adult beetles) was reported. We have in this article reported our studies on the fecundity of the female adult beetle. Studies on the longevity of the adult beetle and the survivorship of the various immature stages of the beetle are also reported. It is anticipated that these studies would provide useful and information that form part of the life history of this pestiferous beetle, since relatively little is known about the beetle habit.

MATERIALS AND METHODS

The longevity studies were carried out under ambient and room conditions. Back yard vegetable garden, insect cages to accommodate host plant and adult beetles were some of the facilities used for the experiment. Adult female beetles were collected from cultivated spinach garden made up of both edible and wild *Amaranthus* species between 6.30 am – 9.00 am local time, before full sunshine and evening between 6.30 pm – 8.00 pm local time (beetles are known to be least active). They were kept in 2 cages (1 and 2) and monitored regularly until the emergence of the first adult beetle. From the first adult emergence the experimental facility was monitored at interval of 3 hours during both day and night periods to determine the ages of the beetles used for the longevity. Beetles (100 in number) were transferred randomly (irrespective of their sex) from cages 1 and 2 (as they emerged) in to cages 3 and 4 containing spinach plant seedlings grown in a metal container. The

beetles were marked with different dye colours for easy identification before they were transferred and placed out side of a building. They were monitored regularly until they died. In the case of plant wilting and defoliation due to the activities of the beetles, fresh plants were replaced. Longevity of beetles under room (temperature) conditions was carried out in cage 5 using hundred beetles of known ages and placed inside the lab. The cage was supplied with a spinach plant seedling (which was replaced with fresh ones when necessary) grown in a metal container. The room temperature was recorded regularly using standard mercury in glass thermometer. The beetles were also marked with different dye colour for easy identification, they were subsequently monitored regularly and results recorded. Longevity of starved beetles at room temperature; Ten marked beetles of known ages were collected from cages 1 and 2 and kept in a container inside a room without food of any sort. These beetles were observed regularly and recorded until the death of the last beetle. Survival rate of the immature stages of the beetles was studied using ten mated female beetles which were supplied with stems of spinach plant for oviposition. After oviposition, the plant stems were collected dissected and the number of the egg inside recoded. The plant stem was held back in position subsequently with cello-tape and stood in a jar of water to retain its freshness. The various stages of the immature stages of the beetles were observed at two-day intervals. From the results recoded various measures from the comparison of mortality factors under room temperature were calculated as described by Southwood (1978). Ten adult beetles' pairs (males and females) of known ages was used for the fecundity. They were put inside glass containers with perforated tops. Each couple was supplied with cut leaf-bearing stems of spinach plant measuring between 3 to 5 cm long for feeding and for oviposition every tow days. Between 6 and 7 pm local time of the second day, the stem was dissected and with the aid of fine wet brush all eggs seen were removed and counted for each couple. This continued until the female stopped laying eggs, or died. During the observation, the male beetles only were replaced in the case of death. Total number of eggs laying days for the female was recorded against the number of eggs laid. Fecundity table was constructed consequently and fecundity rates (M_x).

Data Analysis: The following parameters were estimated thus: Apparent Mortality = X_1 Population – X_2 Population / X_1 Population x 100; Apparent Natality = X_2 Population / X_1 Population x 100; Real Mortality = Egg Population – X_2 population / Egg population x 100; Real Natality = X_2 Population / Egg Population x 100; Overall Real Mortality = Egg population – Population of Emergent Adults / Egg Population x 100 and Overall Real Natality = Population of Emergent Adults / Egg Population x 100. All data were analysed using SPSS version 16.

RESULTS AND DISCUSSION

Longevity of the Adult Beetle: The longevity of the adult beetles was studied under varying conditions. Detailed result of the longevity studies (i.e. the age-related specific longevity analysis) of the beetles under ambient conditions (with prevailing day time temperature range of 27 – 33 ^{o}C and night time temperature range of 21 – 23 ^{o}C) as well as the longevity studies of the beetles under room temperature conditions of approximately 26 ^{o}C average (range: 27 – 34 ^{o}C) and the longevity of the starved beetles studied under room conditions are presented in Table 1.

Table 1: Longevity of *Gasteroclisus rhomboidalis* staved or fed *Amarantus hybridus* leaves and exposed to ambient or room temperatures condition

Age range (in days)	Longevity in days	
	Ambient conditions	Room conditions
1 - 70	41.95 ± 24.76	31.5 ± 22.43
Starved	8.2 ± 2.18	8.2 ± 2.18
Fed	41.95 ± 24.76	31.5 ± 22.43

The observed longevity of the adult beetles under near natural conditions varied widely from 1 – 70 days. This was the pattern also for the longevity under room conditions, which varied from 12 – 68 days. Notwithstanding the wider range of longevity for the beetles under ambient conditions, it was observed that the beetles generally lived longer under the ambient conditions (with mean age of 41.95 ± 24.76 days) when compared with the room conditions (mean age of 31.5 ± 22.43 days). This is understandable, since the ambient conditions were natural compared to the more artificial conditions under room temperature. There was no marked difference in the ages of the longest living adult beetles for both conditions, though higher longevity was achieved at ambient conditions. It is anticipated that the longevity of the beetles under "ambient conditions" may in fact be shorter than has been observed since they were placed in experimental cages and thus had limited access to predation under full natural condition. As anticipated, there was a marked difference in the longevity of the beetles when starved compared to when fed.

Table 2: Survival rates of immature stages (egg, larvae and pupae) of *Gasteroclisus rhomboidalis* fed *Amarantus hybridus* leaves and under room temperatures condition

Plant Number	Number of Oviposition holes	Number of Eggs	% App. Mort.	% App. Natal.	% Real Mort.	% Real Natal.	Number of Larva	% App. Mort.	% App. Natal.	% Real Mort.	% Real Natal.	Number of Pupa	% App. Mort.	% App. Natal.	% Real Mort.	% Real Natal.	Number of adult emerged
1	7	7	29	71	29	71	5	60	40	71	29	2	50	50	86	14	1
2	10	4	50	50	50	50	2	100	0	100	0	0	-	-	100	0	0
3	6	6	17	83	17	83	5	40	60	50	50	3	0	100	50	50	3
4	15	10	40	60	40	60	6	0	100	40	60	6	50	50	70	30	3
5	7	4	25	75	25	75	3	67	33	75	25	1	0	100	75	25	1
6	4	4	0	100	0	100	4	75	25	75	25	1	100	0	100	0	0
7	15	12	17	83	17	83	10	70	30	75	25	3	33	67	83	17	2
8	4	3	0	100	0	100	3	67	33	67	33	1	100	0	100	0	0
9	5	5	20	80	20	80	4	50	50	60	40	2	0	100	60	40	2
10	12	10	40	60	40	60	6	33	67	60	40	4	25	75	70	30	3
Total	85	65	26	74	26	74	48	52	48	65	35	23	30	70	75	25	16

Table 3: Various measures for the comparison of mortality factors in *G. rhomboidalis* under room temperature

Developmental stages	Eggs	(Interval)	Larva	(Interval)	Pupa	(Interval)	Adult
Population surviving at the beginning of each stage, Lx	65		48		23		15
Population dead at the interval between stages, Dx		17		25		8	
% Apparent mortality	26.2		52.1		34.8		
% Real mortality	26.2		38.5		12.3		
Mortality / survivor ratio	0.35		1.09		0.53		

Table 4: Age specific fecundity rates of adult *G. rhomboidalis* under room temperature

Beetle Number	Date of emergence of adult beetle	Date of death in 2001	Life span	Start of egg laying	Age at Start of egg laying	Stop of egg laying	Egg laying duration (days)	Total Number of eggs laid	Rate of egg laying (Number per day)	[Egg-laying duration] / [life span]
1	9/6	8/8	60	11/6	2	2/8	52	195	3.75	0.87
2	2/6	17/7	45	5/6	3	3/7	28	56	2.00	0.62
3	5/6	4/8	60	7/6	2	2/8	56	80	1.43	0.92
4	5/6	2/8	58	7/6	2	2/8	56	148	2.64	0.97
5	5/6	6/8	62	11/6	6	6/8	56	64	1.14	0.90
6	7/6	23/6	16	9/6	2	23/6	14	64	4.57	0.88
7	7/6	19/6	12	9/6	2	19/6	10	20	2.00	0.83
8	7/6	19/6	12	9/6	2	19/6	10	38	3.80	0.83
9	7/6	23/7	46	9/6	2	11/7	32	58	1.81	0.70
10	9/6	17/7	38	11/6	2	3/7	22	46	2.09	0.58
Total			409		25		336	769	25.23	8.10
Mean			40.9		2.5		33.6	76.9	2.52	0.81
Std. Dev.			20.57		1.27		19.75	53.59	1.14	0.13

Correlation coefficient between life span and total number of eggs laid = 0.63; Correlation coefficient between life span and rate of egg laying = -0.48

The calculated average age of 8.2 ± 2.18 days of beetles when starved from emergence was markedly lower than when they were fed [41.95 days (ambient) and 31.5 days (room temperature)]. As was equally anticipated starving the beetles at a more mature age when they are expectedly more desirous of food, produced still lower average longevity of 5 days. In this respect it is remarkable that amongst the mature starved beetles studied, those that emerged at a latter date (i.e. younger ones) before their starving commenced, lived longer when compared with their older colleagues.

In Tables 1, 2 and 3 are illustrated the decrease in survivorship with longevity for the three cases studied, viz., under ambient, room temperature and starved conditions respectively. These tables show a clearer picture of the comparative longevity of the beetles under the three conditions. The LT_{50} which is analogous to the half-life of the beetle population (i.e. the longevity or age at which the population is reduced to half of its initial value) is 38, 24 and 6 days for ambient, room temperature and starved conditions respectively. It can be seen markedly that the beetles live longest under ambient conditions, followed by the room conditions with the starved beetles showing a significantly lower longevity.

Survivorship of Immature Stages of G. *rhomboidalis*: The comparative survivorship (defined by mortality or natality) of the various immature stages of *G. rhomboidalis*, (viz., egg, larval and pupal stages) from 10 female beetles studied under room (temperature) condition are presented in Tables 2 and 3. In Tables 2 the apparent mortality and natality for each of the immature stages is defined as the percentage survivorship (i.e. mortality and natality of a succeeding immature stages relative to the immediate preceding stage .The real percentage mortality or natality, is the survivorship of a particular immature stages relative to the population at the beginning of that generation (i.e. the egg stage).

Table 3 shows the summary of the survivorship of the entire population of the various immature stages for the 10 studied beetles. The various mortality and natality rates have been calculated using equations 4.1 – 4.6 below. It can be seen very clearly that the larval stage has the highest average apparent and real mortality of 52 % and 65 %, respectively and concomitantly, the lowest average apparent and real natality amongst the 3 immature stages. The pupal stage exhibited the next high mortality .The highest surviving stage is the egg. The mortality/survivorship ratio for the entire population of the generation for the 10 beetles studied (Table 3) also very clearly illustrates this pattern. Here the larval stage has the highest mortality / survivorship ratio of 1.09 compared to 0.53 and 0.35 for the pupal and egg stages, respectively. This observation agrees with the previous observation by (Southwood, 1978) that mortality rates in immature stages of the beetles are most at particular stage. It was observed that the creamy white eggs of the beetles were preyed upon both in wild and in the laboratory by the Formicidae (ants) while the larva and pupa were preyed upon only in the wild by *Forficula* commonly referred to as the earwig. This gives insight into potential natural control measures.

Fecundity: The age related fecundity of 10 female beetles studied, are presented in Table 4. It was observed very remarkably that the used about 80% of their life span in egg laying. Egg laying commenced almost in all cases after just 2 days of emergence of the female adult beetle. On the average, about 2½ eggs are laid per day (i.e. about 5 eggs laid within 2 days). The total number of eggs laid by a female beetle is largely a function of its life span. A correlation of the life span with the total number of egg laid had a weak positive correlation of 0.63. In most of the cases the longer the beetle lived the more egg s it laid and this varied widely. This is as anticipated since the egg laying duration per life span remained largely the same for most of the beetles. However, a correlation of the life span with the rate of egg laying (i.e. the number of egg laid per day) had a weak negative correlation of -0.48. A weak negative correlation is indeed anticipated here as it is expected that the beetles would have an optimum egg laying life span beyond which the fecundity decreased with life span. This is more clearly illustrated in Table 4 where a fecundity peak is recorded for a life span of 16 days. In general, the egg laying rate remained largely comparable from the 10 beetles studied.

Conclusion: The longevity of the beetles was studied under a variety of conditions. It was observed that the life span of the beetles varied widely with the beetles capable of living up to 70 days (about 42 days on the average). The beetles generally lived longer under the ambient condition than inside room condition. Studies on the survivorship of the immature stages of the beetles revealed that the larva had the largest mortality rate amongst the immature stages with the egg being the highest surviving stage. This result is very useful for studies on control of the pest as the pest management

procedure adopted is determined by the knowledge of the stage with the highest survivorship. Studies on the fecundity of the female adult beetles showed that about 80% of their life span is utilised in egg laying. Egg laying commenced, almost in all cases after just 2 days of emergence of the female adult beetle. On the average, about 2 ½ eggs are laid per day (i.e. about 5 eggs laid within 2 days.)

REFERENCES

DAVIDSON, R. H. and LYON, W. E. (1979). *Insects, pests of farm, garden and orchards.* 7th edition, John Wiley and Sons, New York.

EKECHUKWU, N. E. (2002). Biological studies of *Gasteroclisus rhomboidalis* (Coleoptera: Curculionidae) on *Amaranthus* species. M. Sc. Project Report, University of Nigeria, Nsukka.

ELUWA, M. C. (1977). Studies on *Gasteroclisus rhomboidalis* (Boheman) (Coleoptera: Curculionidae), a pest of the African spinach. *Journal of Natural History,* 11: 417 – 424.

ELUWA, M. C. (1979). Biology of *Lixus camerunus* (Kolbe) (Coleoptera: Curculionidae), a major pest of the edible *Vernonias* (Compositae) in Nigeria. *Revista Zoologia Africana,* 93(1): 230 – 240.

EZE, J. M. O. (1986). Growth of *Amaranthus hybridus* (African spinach) under different day light intensities in the dry season in Southern Nigeria. *Experimental Agriculture,* 23(2): 193 – 200.

KEAY, R. W. J. (1973). *Flora of West Tropical Africa*. 2nd Edition, White Friars Press Limited, London.

KIRKPATRICK, T. W. (1957). *Insect life in the Tropics.* Longman, London.

PURSEGLOVE, T. W. (1987). *Tropical crops: Dicotyledons*. Longman Publishers, Scientific and Technical, London.

ROSS, H. (1965). *A textbook of entomology,* 3rd edition, John Wiley and Sons, New York.

SOUTHWOOD, T. R. E. (1978). *Ecological methods; with particular reference to the study of insect population.* Chapman and Hall, London.